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MAGNETIC RECORDING MEDIUM, MAGNETIC HEAD, AND MAGNETIC RECORDING DEVICE
[Jikikirokubaitai Oyobi Jikiheddo Oyobi Jikikirokusohchi]

Hirohisa Ishihara, et al.

UNITED STATES PATENT AND TRADEMARK OFFICE
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TITLE (54): MAGNETIC RECORDING MEDIUM, MAGNETIC HEAD, AND MAGNETIC RECORDING DEVICE

FOREIGN TITLE (54A): JIKIKIROKUBAITAI OYOBI JIKIHEDDO OYOBI JIKIKIROKUSOHCHI

(Claims)

(Claim 1) In a magnetic recording medium on which recording·reproduction of information is performed by relative movement with respect to a magnetic head, the magnetic recording medium is characterized by the fact that many protruding patterns are formed at least in the region where the magnetic recording medium contacts the magnetic head and slides, and the protruding patterns densely exist continuously in the direction of relative movement with respect to the magnetic head.

(Claim 2) A magnetic recording medium characterized by the fact that spacings, L1 and L2, of the protruding patterns described in claim 1 are related by $L1 \leq L2$, in which L1 is the spacing in the direction of relative movement with respect to the magnetic head and L2 is the space in the direction perpendicular to the relative movement.

(Claim 3) In a magnetic head with which recording·reproduction of information is performed by relative movement with respect to a magnetic recording medium, the magnetic head is characterized by the fact that many protruding patterns are formed at least in a part of surface where the magnetic head contacts the magnetic recording medium and slides, and the protruding patterns densely exist continuously in the direction of relative movement with respect to the magnetic recording medium.

(Claim 4) A magnetic head characterized by the fact that spacings, L1 and L2, of the protruding patterns described in claim 3 are related by $L1 \leq L2$, in which L1 is the spacing in the direction of relative movement with respect to the magnetic recording medium and L2 is the space in the direction perpendicular to the relative movement.

(Claim 5) A magnetic recording device characterized by the fact that either one or both of the magnetic recording mediums described in claim 1 or claim 2 and the magnetic head described in claim 3 or claim 4 are used.

(Detailed explanation of the invention)

(Industrial application) This invention relates to a magnetic recording medium and magnetic head and a magnetic recording device on which they are mounted. Particularly, this invention intends to prevent the poor starting of a magnetic recording device due to adsorption phenomenon and to improve the sliding durability.

(Conventional techniques) Recording·reproduction are performed by the relative movement of a magnetic recording medium and a magnetic head. Therefore, the sliding surface where the magnetic recording medium and the magnetic head make contact and slide have to be very smooth in order to avoid abrasion and damage formation. Also, in a magnetic disk device which is an external memory device for computers using a floating type head, similarly high smoothness is required in order to ascertain stable floating of the magnetic head.

However, strong adsorption phenomenon occurs at the surface where the highly smooth magnetic recording medium and magnetic head make contact, caused by moisture content in the air and the lubricant which is applied in order to improve the durability. The same problem also exists in magnetic disk devices in which a floating type head is used since the magnetic recording medium and the magnetic head still make contact when the device is not in operation.

In the past, in order to solve such problems a method wherein the

surface where a magnetic recording medium and a magnetic head make contact is roughened has been generally adopted. For example, as a method for roughening a magnetic recording medium for magnetic disk device (in what follows, this is simply called a magnetic disk), non-uniform fine unevenness (i.e., the concave and convex parts which is called a texture) is formed on the surface of a substrate by a mechanical method or by a chemical etching method.

However, it is extremely difficult to prepare the desired fine concave and convex parts by the aforementioned mechanical method or chemical etching method. In addition, it is difficult to quantify the characteristic value of the surface shape.

Accordingly, a magnetic recording medium and a magnetic head has been proposed to solve the aforementioned problems. Namely, fine protruding patterns are formed by a photolithographic technique on the surface where the magnetic recording medium and the magnetic head make contact.

(Problems this invention intends to solve) With the aforementioned photolithographic technique, fine protruding patterns having prescribed shape can be accurately formed on the surface where the magnetic recording medium and the magnetic head make contact. However, there still is the difficulty of optimally solving the problems related to the adsorption phenomenon between the magnetic recording medium and the magnetic head and sliding durability.

In conventional examples, it is not clear, in detail, how to form protruding patterns.

Conventional examples in which the shape of protruding pattern

which is to be formed in a magnetic recording medium and a magnetic head is specified are presented below. In Japanese Patent Kokai Hei 3-91117, area ratio of a protruding pattern is specified as 1% or less. In Japanese Patent Kokai Hei 3-173917, area ratio of a protruding pattern is specified as 0.001-1% and its shape is specified as rectangular (cross-sectional area). In Japanese Patent Kokai Hei 3-250420, the number of protruding patterns (300Å or larger) is specified to be 10/mm^2 or less. As mentioned above, only the area ratio and the number of protruding patterns are specified.

However, in the conventionally formed magnetic disk with the specification only of area ratio and the number, arrangement of protruding patterns is not specified. As a result, the problems related to the aforementioned adsorption phenomenon between a magnetic recording medium and a magnetic head and sliding durability cannot be optimally solved.

This invention intends to solve the aforementioned problems and to propose a magnetic recording medium and a magnetic head having optimal protruding patterns with which adsorption between the magnetic recording medium and the magnetic head can be prevented and sliding durability can be improved, and to propose a magnetic recording device in which these magnetic recording medium and magnetic head are used.

(Means for solving the problems) In order to achieve the aforementioned purposes, the invented magnetic recording medium described in claim 1 is characterized by the fact that many protruding patterns are formed at least in the region where the magnetic recording medium contacts the magnetic head and slides, and the protruding

patterns do densely exist continuously in the direction of relative movement with respect to the magnetic head.

The invented magnetic recording medium described in claim 2 is characterized by the fact that spacings, L1 and L2, of protruding patterns described in claim 1 are related by $L1 \leq L2$, in which L1 is the spacing in the direction of relative movement with respect to the magnetic head and L2 is the space in the direction perpendicular to the relative movement.

The invented magnetic head described in claim 3 is characterized by the fact that many protruding patterns are formed at least in a part of surface where the magnetic head contacts the magnetic recording medium and slides, and the protruding patterns do densely exist continuously in the direction of relative movement with respect to the magnetic recording medium.

The invented magnetic head described in claim 4 is characterized by the fact that spacings, L1 and L2, of protruding patterns described in claim 3 are related by $L1 \leq L2$, in which L1 is the spacing in the direction of relative movement with respect to the magnetic recording medium and L2 is the space in the direction perpendicular to the relative movement.

The magnetic recording device described in claim 5 is characterized by the fact that either one or both of the magnetic recording medium described in claim 1 or claim 2 and the magnetic head described in claim 3 or claim 4 are used.

(Operation) According to the invented magnetic recording medium described either in claim 1 or claim 2, protruding patterns of

prescribed shape can be optimally (with respect to adsorption between a magnetic recording medium and a magnetic head and sliding durability) arranged at least in the region where the magnetic recording medium contacts the magnetic head and slides.

According to the invented magnetic head described either in claim 3 or claim 4, protruding patterns of prescribed shape can be optimally (with respect to adsorption between a magnetic recording medium and a magnetic head and sliding durability) arranged at least in a part of the surface where the magnetic head contacts the magnetic recording medium and slides.

According to the invented magnetic recording device described in claim 5, adsorption between a magnetic recording medium and a magnetic head can be accurately prevented, and sliding durability can be improved.

(Application examples) In what follows, application examples of this invention are explained by referring to Figure 1 through Figure 12. First, application examples of a magnetic recording medium are explained by referring to Figure 1 through Figure 8.

Figure 1 is a plane diagram showing an application example in which the invented magnetic recording medium is adopted in a magnetic disk. Figure 2 is a partially magnified plane diagram in which a part of the region where the magnetic recording medium contacts the magnetic head and slides is magnified.

As shown in Figure 1, the magnetic disk (1) described in this application example is formed in a ring-shape having a regular thickness like a conventional disk. And, the prescribed range in the inside is set

as a CSS (contact·stop·slide) region (2) where the magnetic disk contacts the magnetic head and slides at the time of start·stop of the magnetic recording device, and the prescribed region at the outer periphery of the aforementioned CSS region (2) is set as a data region (3) where information processing by the magnetic head (not shown in the figure) is performed.

This magnetic disk (1) is manufactured by sequentially forming foundation layer, magnetic layer, protection layer, and lubrication layer (at prescribed thickness) on one surface or on both surfaces of a substrate which is manufactured in a ring-shape using a proper raw material such as metal, glass, resin, and Ni-P-plated aluminum alloy. These layers are formed by a proper film forming method such as a sputtering method. For instance, as a foundation layer, a Cr layer using Cr as a raw material and the like is formed. As a magnetic layer, a Co alloy layer using Co alloy and the like as a raw material is formed. As a protection layer, a C layer using C and the like as a raw material is formed. And, in a lubrication layer, perfluoro polyether polymer and the like is used as a raw material.

Many protruding patterns (4, 4,..,) of a prescribed shape (cylindrical in this application example) are formed in plural rows in the circumferential direction in the CSS region (2) in at least one surface of the aforementioned magnetic disk (1). Height of these protruding patterns is at least 5nm. And, as shown in Figure 2, each of these protruding patterns is so formed that spacings, L1 and L2, are so related as $L1 \leq L2$, in which L1 is the spacing in the direction of relative movement with respect to the magnetic head and L2 is the

spacing in the direction perpendicular to the direction of the relative movement.

Protruding patterns (4) formed on the surface of the magnetic disk described in this application example is explained by referring to Figure 3.

Figure 3 is a magnified cross-sectional diagram showing the important part of the protruding patterns. As shown in Figure 3, protruding patterns (4) in this application example are formed in the following manner. Namely, photoresist is coated on a ring-shaped substrate (5). Then, this substrate is subjected to light exposure, development, and etching using a specifically patterned photomask. Then, the photoresist is removed to form cylindrical protruded parts (6). Thereafter, the aforementioned foundation layer (7), magnetic layer (8), protection layer (9), and lubrication layer (10) (each having a prescribed thickness) are sequentially formed. By this way, protruding patterns (4) having prescribed height (H) are formed.

In this application example, shape of the protruding patterns (4) is cylindrical. However, it is not limited to what is used in this application example; the shape can be another regular shape such as prism-shape, truncated cone-shape, and truncated pyramid-shape.

Furthermore, in this application example, protruded patterns (4) are formed in the CSS region (2). These protruded patterns, however, can be formed in other regions. That is, it is not limited to what is described in this application example. Protruded parts (6) can be formed not only by a photoetching technique, but also by other regular methods such as an electrical discharge technique and a laser technique. That

is, it is not limited to the technique described in this application example.

Next, operation of the device described in this application example is explained by referring to a detailed application example.

Application example 1

As shown in Figure 3 and Figure 4, as a magnetic disk (1), plural rows of cylindrical protruding parts (6) were formed in the circumferential direction on the glass substrate (5) by a photoetching technique. Spacings, L1 and L2, were related as L1≤L2, in which L1 is the spacing in the direction of relative movement with respect to the magnetic head and L2 is the spacing in the direction perpendicular to the direction of the relative movement. In this application example, L1:L2=1:5. The foundation layer (7) using Cr as the raw material, the magnetic layer (8) using Co alloy as the raw material, and the protection layer (9) using C as the raw material were sequentially formed on the glass substrate (5). And, furthermore, a lubrication layer was formed to form protruding patterns of prescribed height.

Application example 2

A magnetic disk which was similar to the one described in application example 1 was formed, excepting that spacings, L1 and L2 (L1≤L2), of protruding patterns (4) described in application example 1 was changed to L1:L2=1:2.

Application example 3

A magnetic disk which was similar to the one described in application example 1 was formed, excepting that spacings, L1 and L2 (L1≤L2), of protruding patterns (4) described in application example 1

was changed to L1:L2=1:1.

Comparison example 1

A magnetic disk which was similar to the one described in application example 1 was formed, excepting that spacings, L1 and L2 (L1>L2), of protruding patterns (4) described in application example 1 was changed to L1:L2=2:1 as shown in Figure 5.

CSS was repeated using minimonolithic ferrite head to the aforementioned magnetic disks, and the change of friction coefficient between the magnetic disk (1) and the magnetic head was measured.

Results of the measurement are shown in Figure 6. As is clear from Figure 6, the relation between spacings, L1 and L2, of protruding patterns at which the startable condition of the magnetic disk device (i.e., friction coefficient of 0.8 or lower after 30,000 of CSS operation) can be satisfied is L1≤L2. When L1>L2, friction coefficient becomes 1.0 or higher.

As described above, according to the magnetic disk (1) described in this application example, CSS durability can be significantly improved as compared to the conventional magnetic disk.

Furthermore, the similar effect can be obtained when spacings of protruding patterns (4) to be formed on the invented magnetic disk (1) are like those shown in Figure 7 and Figure 8.

Figure 7 is a partially magnified plane diagram in which a part of region where the magnetic disk (1) contacts the magnetic head and slides is magnified. When protruding patterns (4) are arranged in a zigzag form as shown in Figure 7, superior CSS durability can be obtained by maintaining the relation of L1≤L2 between spacings of protruding

patterns.

Figure 8 is a partially magnified plane diagram in which a part of region where the magnetic disk (1) contacts the magnetic head and slides is magnified. When protruding patterns (4) are arranged continuously or partially discretely in the direction of relative movement with respect to the magnetic head as shown in Figure 8, superior CSS durability can be obtained since protruding patterns (4) are densely existing continuously in the direction of he relative movement with respect to the magnetic head.

Furthermore, protruding patterns (4) to be formed on this invented magnetic disk (1) can be formed on the protection film (10), instead of forming on the substrate (5) as described in application examples

Next, an application example of the invented magnetic head is explained by referring to Figure 9 and Figure 10. Figure 9 is a strabismus diagram showing the entirety of the application example in which the invented magnetic head is adopted in a 3-rail monolithic magnetic head. Figure 10 is a partially magnified plane diagram in which a part of sliding surface of the invented magnetic head is magnified.

As shown in Figure 9, the invented magnetic head (27) is equipped with a short, approximately rectangular slider (28) which is formed with polycrystalline Mn-Zn ferrite and the like. Two grooves (30, 30) are set in parallel to the direction of relative movement with respect to the magnetic disk on the sliding surface (29) (shown by slanted lines in the figure) of this slider (28) to form three rails (31). This sliding surface (29) is an ABC (i.e., an Air Bearing Surface) facing the magnetic disk (not shown in the figure). One rail (31) at the center is

joined to an approximately ⊐-shaped head core (32), which is made of polycrystalline Mn-Zn ferrite, by glass (not shown in the figure) via a regular gap (33). A desired coil (35) is wound around the head core (32). By introducing electric current to the coil (35) or by detecting induced current, recording·reproduction of information is performed at the gap (33) part.

Furthermore, in the three rails (31) which constitute the sliding surface (29) of the magnetic head (27), plural rows of protruding patterns (4C) of a desired shape (in this application example, cylindrical protruding patterns similar to those formed in the magnetic disk (1) described earlier are formed). Spacings of the protruding patterns are related by $L1 \leq L2$, in which L1 is the spacing in the direction of relative movement with respect to the magnetic disk and L2 is the spacing in the direction perpendicular to the direction of the relative movement.

Protruding patterns (4C) to be formed on the surface of magnetic head (27) described in this application example are formed by the following method. Namely, photoresist is coated on the sliding surface (29) of the slider (28), which is then subjected to light exposure, development, and etching using a specifically patterned photomask. Then, the photoresist is removed from the substrate to form protruding patterns (4C) of prescribed height.

In this application example the shape of the protruding patterns (4C) is cylindrical. However, it is not limited to what is used in this application example; the shape can be another regular shape such as prism-shape, truncated cone-shape, or truncated pyramid-shape.

Furthermore, in this application example, protruding patterns (4C) are formed on all three of the rails (31) which constitute the sliding surface (29). Alternatively, protruding patterns can be formed only on rails at both sides (among the three rails (31) which constitute the sliding surface (29)). Instead of forming protruding patterns over the entire rail (31) surface, these protruding patterns can be formed only on part of the rail (31) surface. In other words, it is not limited to what is described in this application example. And, protruding patterns (4C) can be formed not only by a photoetching technique, but also by an electrical discharge technique or a laser technique. In other words, the method of forming protruding patterns is not limited to what is used in this application example.

Furthermore, in this application example, protruding patterns (4C) are formed by photoetching the polycrystalline Mn-Zn ferrite which forms the slider. Alternatively, after a thin carbon (C) film is formed on the sliding surface (29), protruding patterns (4C) can be formed on the carbon layer by a photoetching technique. In other words, the method of forming protruding patterns is not limited to what is used in this application example.

It is clear that, with the magnetic head (27) which is constituted as described, adsorption can be accurately prevented and CSS durability can be significantly improved as compared to the conventional magnetic heads.

The reason is explained below. Since a magnetic disk and a magnetic head make contact and slide during the CSS operation, the relationship between the arrangement of protruding patterns and the CSS durability

which is established in the aforementioned magnetic disk (1) can be applied to the relationship between the arrangement of protruding patterns and the CSS durability in the magnetic head (27). And, the similar effect can be realized.

Next, an application example in which the invented magnetic recording device is applied to a magnetic disk device is explained by referring to Figure 11 and Figure 12. Figure 11 is a plane diagram showing the important parts of an application example of the invented magnetic disk device. Figure 12 gives its side view.

As shown in Figure 11 and Figure 12, in the magnetic disk device (36) described in this application example, the magnetic head (37) is installed at the tip of an elastic arm of the supporting device (38) and is held suspended above the magnetic recording medium (39). By rotating the magnetic recording medium (39), the magnetic head is allowed to scan the surface of the magnetic recording medium (39) to perform recording·reproducing. In the magnetic head (37) of the magnetic disk device (36), the aforementioned magnetic head (27) in which protruding patterns (4C) are formed on the sliding surface (29) is used.

As explained thus far, according to the magnetic disk device (36) which is described in this application example, CSS durability and adsorption characteristics can be significantly improved.

Furthermore, similar effects can also be realized by using a conventional magnetic head in the place of the magnetic head (37) of the magnetic disk device (36) and by using the aforementioned magnetic disk (1) as the magnetic recording medium (39).

In other words, by using the magnetic disk (1) or/and magnetic head

(27) described in these application examples in either one or both of the magnetic head (37) of the magnetic disk device (36) and the magnetic recording medium (39), the device can last longer and stable quality can be obtained for a long period of time.

Furthermore, this invention is not limited to what is described in the aforementioned application examples. This invention can be modified as needed.

(Effects of the invention) As explained thus far, according to the invented magnetic recording medium, protruding patterns to be formed on a magnetic recording medium can be accurately and optimally arranged and can be clearly displayed. Magnetic recording media having such superior technical effects can be manufactured precisely and accurately with stable quality.

As explained thus far, according to the invented magnetic head, protruding patterns to be formed on a magnetic head can be accurately and optimally arranged and can be clearly displayed. Magnetic heads having such superior technical effects can be manufactured precisely and accurately with stable quality.

Furthermore, according to the invented magnetic recording device, the device can last longer and stable quality can be maintained for a long period of time.

(Brief explanation of figures)

(Figure 1) Figure 1 is a plane diagram showing an application example of the invented magnetic recording medium.

(Figure 2) Figure 2 is a magnified plane diagram (in which the surface part is magnified) of the invented magnetic recording medium.

(Figure 3) Figure 3 is a magnified cross-sectional diagram showing the important parts of the protruding patterns of an invented magnetic recording medium.

(Figure 4) Figure 4 is a magnified plane diagram (in which the surface part is magnified) of an invented magnetic recording medium.

(Figure 5) Figure 5 is a magnified plane diagram (in which the surface part is magnified) of a conventional magnetic recording medium.

(Figure 6) Figure 6 is a diagram showing the relationships between the protruding pattern spacings and friction coefficient of an invented magnetic recording medium.

(Figure 7) Figure 7 is a magnified plane diagram (in which the surface part is magnified) of an invented magnetic recording medium.

(Figure 8) Figure 8 is a magnified plane diagram (in which the surface part is magnified) of an invented magnetic recording medium.

(Figure 9) Figure 9 is a strabismus diagram showing the entirety of an application example in which the invented magnetic head is adopted in a 3-rail monolithic magnetic head.

(Figure 10) Figure 10 is a partially magnified plane diagram in which a part of sliding surface of an invented magnetic head is magnified.

(Figure 11) Figure 11 is a plane diagram showing the important parts of an application example of an invented magnetic recording device.

(Figure 12) Figure 12 gives the side view of the device shown in Figure 11.

(Symbols)

1...magnetic disk

2...CSS region

3...data region

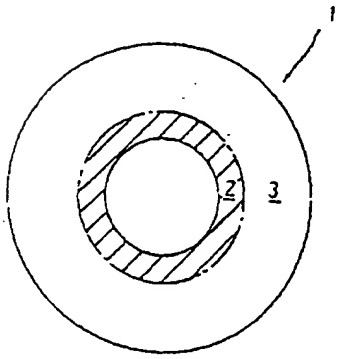
4, 4C...protruding patterns

27..magnetic head

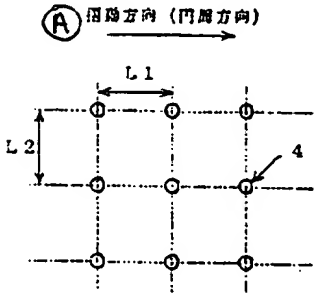
29..sliding surface

31..rail

36..magnetic recording device

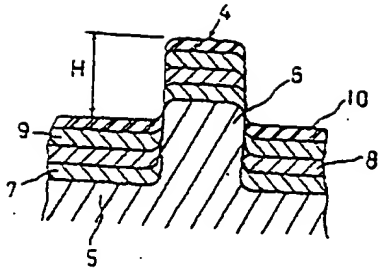


(Figure 1)

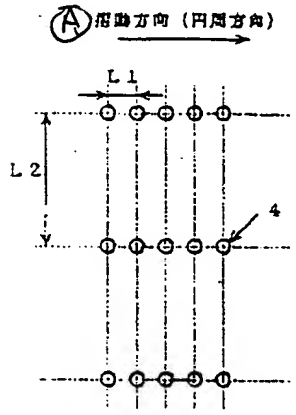


(Figure 2)

[Key:]
[A] direction of sliding (circumferential direction)



(Figure 3)



(Figure 4)

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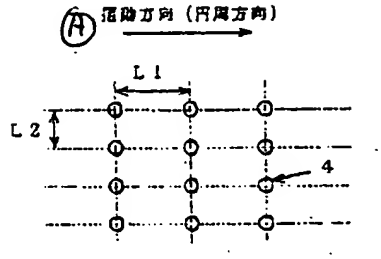

(Figure 5)

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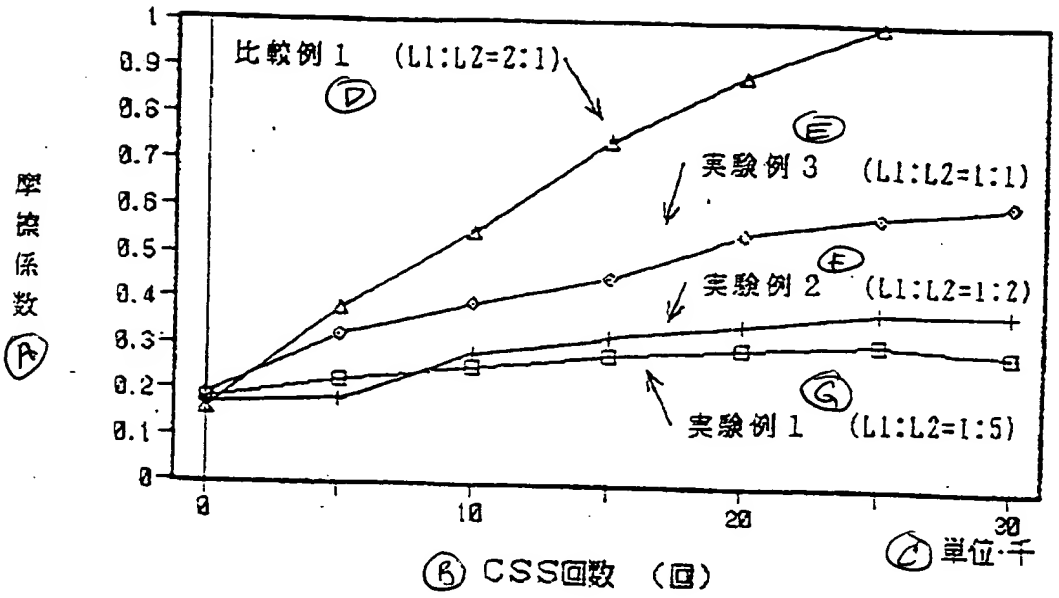
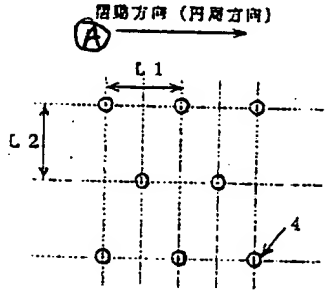


(Figure 6)

[Key:]
[A] friction coefficient
[B] CSS frequency (times)
[C] unit: 1000
[D] Comparison example 1 (L1:L2=2:1)
[E] Application example 3 (L1:L2=1:1)
[F] Application example 2 (L1:L2=1:2)
[G] Application example 1 (L1:L2=1:5)



(Figure 7)

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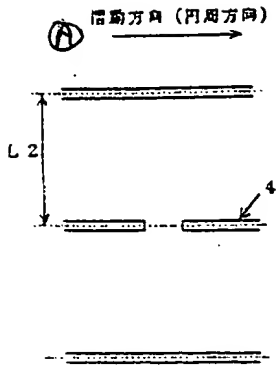

(Figure 8)

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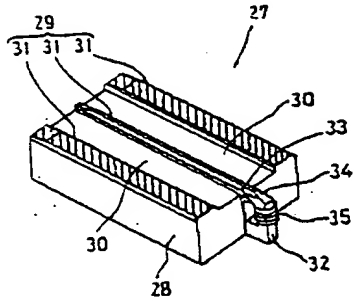
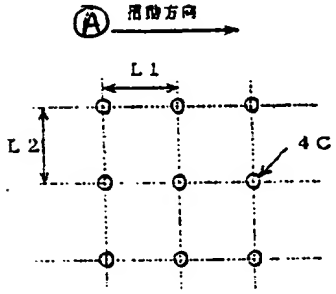
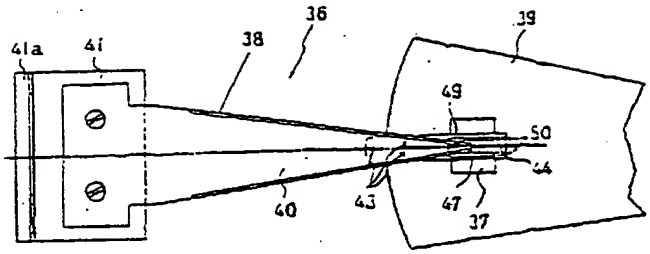


(Figure 9)

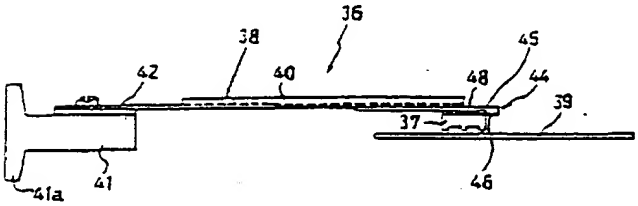


(Figure 10)

[Key:]
[A] direction of sliding



(Figure 11)



(Figure 12)

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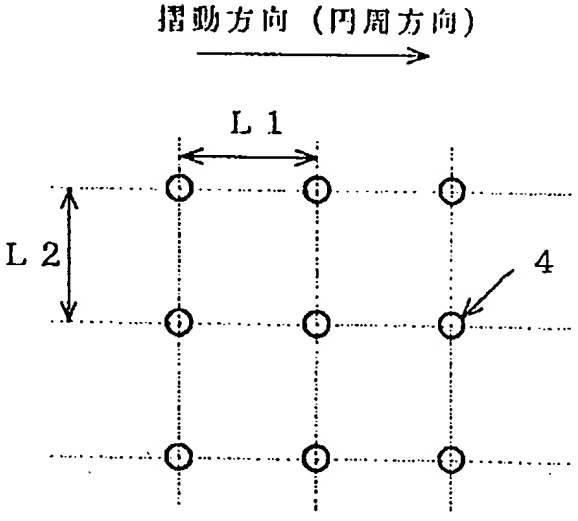
(54)【発明の名称】　磁気記録媒体及び磁気ヘッド及び磁気記録装置

(57)【要約】
【目的】　磁気ヘッドと磁気記録媒体との吸着を確実に防止するとともに，摺動耐久性を向上した最適の突起状パターン４を有する磁気ヘッドおよび磁気記録媒体ならびに磁気記録装置を提供する。
【構成】磁気記録媒体の少なくとも磁気ヘッドと接触，摺動を行なう領域に突起状パターンを多数形成し，磁気ヘッド２７の少なくとも磁気記録媒体と対向する摺動面の一部に突起状パターン４Ｃを多数形成するとともに，前記突起状パターン４，４Ｃの形成してある間隔が，磁気ヘッドと磁気記録媒体の相対移動方向の間隔をＬ１，相対移動方向に対し直角方向の間隔をＬ２とすると，
Ｌ１≦Ｌ２
の関係にあることを特徴とする。



【特許請求の範囲】

【請求項１】　磁気ヘッドとの相対移動により情報の記録・再生等を行なう磁気記録媒体において、少なくとも磁気ヘッドと接触し摺動する領域に突起状のパターンが複数形成されており、その突起状のパターンが磁気ヘッドとの相対移動方向に連続して密に存在することを特徴とする磁気記録媒体。

【請求項２】　請求項１に記載の突起状のパターンの形成間隔が，磁気ヘッドとの相対移動方向の間隔をＬ１，相対移動方向に対し直角方向の間隔をＬ２とすると，

Ｌ１≦Ｌ２

の関係にあることを特徴とする磁気記録媒体。

【請求項３】　磁気記録媒体との相対移動により情報の記録・再生等を行なう磁気ヘッドにおいて，少なくとも磁気記録媒体と接触し摺動する面の一部に突起状のパターンが複数形成されており，その突起状のパターンが磁気記録媒体との相対移動方向に連続して密に存在することを特徴とする磁気ヘッド。

【請求項４】　請求項３に記載の突起状のパターンの形成間隔が，磁気記録媒体との相対移動方向の間隔をＬ１，相対移動方向に対し直角方向の間隔をＬ２とすると，

Ｌ１≦Ｌ２

の関係にあることを特徴とする磁気ヘッド。

【請求項５】　請求項１または２に記載の磁気記録媒体および請求項３または４に記載の磁気ヘッドの一方，あるいは，両者を用いたことを特徴とする磁気記録装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は，磁気記録媒体および磁気ヘッドおよびそれを搭載した磁気記録装置に関し，特に吸着現象による磁気記録装置の起動不良を防止し，摺動耐久性を向上させることを図ったものである。

【０００２】

【従来の技術】磁気記録媒体と磁気ヘッドは相対移動して記録・再生等を行なう．よって磁気記録媒体および磁気ヘッドの各々相対する摺動面は，摩耗やキズを避けるために高い平滑性が必要とされた。また浮上型ヘッドを使用するコンピュータ用の外部記憶装置である磁気ディスク装置においても，磁気ヘッドを安定して浮上させるために，同様に高い平滑性が必要とされる。

【０００３】しかし，前述した平滑性を高めた磁気記録媒体および磁気ヘッドの相対する面は，大気中の水分や，耐久性を向上させるために塗布した潤滑剤などによって，強い吸着現象を起こすという問題が有った。浮上型ヘッドを使用する磁気ディスク装置においても，装置停止中は磁気記録媒体と磁気ヘッドは接触するので同様の問題が有った。

【０００４】そこで，従来より上記のような問題を解決するために，磁気記録媒体および磁気ヘッドの相対する面に粗さを設ける方法が一般的にとられた。磁気記録媒体に粗さを設ける方法としては，例えば磁気ディスク装置用の磁気記録媒体（以下磁気ディスクと略称）の場合は基板の表面にテクスチャーと称する不均一な微細な凹凸を機械加工あるいはケミカルエッチング等により設けていた。

【０００５】しかし前記したような機械加工やケミカルエッチング等により設けられた微細な凹凸は，所望の状態に制御することが極めて困難で，しかも，表面形状の特性値の定量化が困難であった。

【０００６】そこで，フォトリソグラフィー技術を用いて磁気記録媒体や磁気ヘッドの相対する面に微細な突起状パターンを形成し，前述した不都合を解決する磁気記録媒体や磁気ヘッドが提案されている。

【０００７】

【発明が解決しようとする課題】しかしながら，前述したフォトリソグラフィー技術を用いた磁気記録媒体および磁気ヘッドにおいては，相対する面に微細な突起状パターンを所定の形状に精度良く形成することは出来るものの，いまだに磁気記録媒体と磁気ヘッドとの吸着現象および摺動耐久性に対する最適化を図ることが出来ないという問題点が有った。

【０００８】なぜならば，従来例においては，各突起状のパターンを具体的に，どのように形成すべきであるか不明確であるからである。

【０００９】この磁気記録媒体および磁気ヘッドに設ける突起状のパターンの形状等の規定について従来例を見ると，例えば，特開平３－９１１１７号公報に記載されているように，突起状パターンの面積比を１％以下とするもの，特開平３－１７３９１７号公報に記載されているように，突起状パターンの面積比を０．００１～１％とし，かつ，その形状を断面矩形としたもの，特開平３－２５０４２０号公報に記載されているように，３００オングストローム以上の突起状パターンの数を１平方ミリメートル当り１０個以内としたもの等のように，突起状パターンの面積比および数のみ規定しているにすぎない。

【００１０】しかし，従来の面積比および個数のみの形状等の規定により形成された磁気ディスクでは，突起状パターンの配置の規定がなされず，前述した磁気記録媒体と磁気ヘッドとの吸着現象および摺動耐久性に対する最適化を図ることが出来ないという問題点が有った。

【００１１】本発明はこれらの点に省みてなされたものであり，前述した従来のものにおける問題点を克服し，磁気記録媒体と磁気ヘッドとの吸着を確実に防止するとともに，摺動耐久性を向上した最適の突起状パターンを有する磁気記録媒体および磁気ヘッドならびにそれらを用いた磁気記録装置を提供することを目的とする。

【００１２】

【課題を解決するための手段】前述した目的を達成する

ために請求項１に記載の本発明の磁気記録媒体は，少なくとも磁気ヘッドと接触し摺動する領域に突起状のパターンが複数形成されており，その突起状のパターンが磁気ヘッドとの相対移動方向に連続して密に存在することを特徴としている。

【００１３】そして，請求項２に記載の本発明の磁気記録媒体は，請求項１において，突起状のパターンの形成間隔が，磁気ヘッドとの相対移動方向の間隔をＬ１，相対移動方向に対し直角方向の間隔をＬ２とすると

Ｌ１≦Ｌ２

の関係にあることを特徴としている。

【００１４】さらに，請求項３に記載の本発明の磁気ヘッドは，少なくとも磁気記録媒体と接触し摺動する面の一部に突起状のパターンが複数形成されており，その突起状のパターンが磁気記録媒体との相対移動方向に連続して密に存在することを特徴としている。

【００１５】また，請求項４に記載の本発明の磁気ヘッドは，請求項３において，突起状のパターンの形成間隔が，磁気記録媒体との相対移動方向の間隔をＬ１，相対移動方向に対し直角方向の間隔をＬ２とすると

Ｌ１≦Ｌ２

の関係にあることを特徴としている。

【００１６】さらに，請求項５に記載の磁気記録装置は，請求項１または２に記載の磁気記録媒体および請求項３または４に記載の磁気ヘッドの一方，あるいは，両者を用いたことを特徴としている。

【００１７】

【作用】請求項１または２に記載の本発明の磁気記録媒体によれば，磁気記録媒体の少なくとも磁気ヘッドと接触し摺動する領域に，所定形状の突起状のパターンを，磁気記録媒体と磁気ヘッドとの吸着をおよび摺動耐久性に対して最適に配置することができる。

【００１８】請求項３または４に記載の本発明の磁気ヘッドによれば，磁気ヘッドの少なくとも磁気記録媒体と接触し摺動する面の一部に，所定形状の突起状のパターンを，磁気記録媒体と磁気ヘッドとの吸着および摺動耐久性に対して最適に配置することができる。

【００１９】請求項５に記載の本発明の磁気記録装置によれば，磁気記録媒体と磁気ヘッドとの吸着を確実に防止し，摺動耐久性を向上することが出来る。

【００２０】

【実施例】以下，本発明の実施例を図１から図１２について説明する。まず，磁気記録媒体の実施例について図１から図８により説明する。

【００２１】図１は本発明の磁気記録媒体を磁気ディスクに適用した一実施例を示す平面図であり，図２はヘッドと接触し摺動する領域の一部を拡大した部分拡大平面図である。

【００２２】本実施例の磁気ディスク１は，図１に示すように，従来と同様に適当な厚さの環状に形成されている。そして，内側の所定範囲は磁気記録装置の起動・停止時に磁気ヘッドと接触・摺動するＣＳＳ（コンタクト・スタート・ストップ）が行なわれるＣＳＳ領域２とされ，前記ＣＳＳ領域２の外周の所定領域は図示しない磁気ヘッドによる情報処理がなされるデータ領域３とされている。

【００２３】また，この磁気ディスク１は，金属，ガラス，樹脂，アルミ合金にＮｉ－Ｐめっきを施したもの等の適当な素材により環状に製せられた基板の一方の表面，あるいは表裏両面に，適当な下地層，磁性層，保護層，潤滑層が所定の厚みで順に形成されている。これらの各層はスパッタリング等の適当な成膜法により，例えば下地層としてクロム（Ｃｒ）を素材としたＣｒ層等が用いられ，磁性層としてコバルト（Ｃｏ）合金を素材としたＣｏ合金磁性層が用いられており，保護層としてはカーボン（Ｃ）を素材としたＣ層等が用いられており，潤滑層としてはパーフルオロポリエーテル重合体等が素材として用いられている。

【００２４】また，前記磁気ディスク１の表面と裏面の少なくとも一方のＣＳＳ領域２には，所定形状，本実施例では円柱状の多数の突起状パターン４，４，・・・が円周方向に複数列形成されるとともに，その高さを５ｎｍ以上とされている。そして，この各突起状パターン４は，図２に示すように，その形成してある間隔が磁気ヘッドとの相対移動方向の間隔をＬ１，相対移動方向に対し直角方向の間隔をＬ２とすると

Ｌ１≦Ｌ２

の関係になるように形成されている。

【００２５】本実施例の磁気ディスクの表面に形成される突起状パターン４について図３により説明する。

【００２６】図３は突起状パターンの要部を示す拡大断面図である。図３に示すように，本実施例の突起状パターン４は，環状の基板５にフォトレジストを塗布し，所定パターンのフォトマスクを用いて露光し，現像，エッチング等を行ない，フォトレジストを基板から除去することで，円柱状の突部６を形成する。その後，この突部６を設けた基板５の表面に前述した下地層７，磁性層８，保護層９，潤滑層１０が所定の厚みで順に形成されて，所定高さＨの突起状パターン４が形成される。

【００２７】なお，本実施例においては，突起状パターン４の形状を円柱状としたが，角柱状，円錐台状，角錐台状等の適当な形状でよく，特に本実施例に限定されるものではない。

【００２８】また，本実施例においては，突起状パターン４をＣＳＳ領域２に形成したが，他の領域に形成してもよく，特に本実施例に限定されるものではない。そして，突部６はフォトエッチングだけでなく，放電加工，レーザ加工等の適当な加工方法により形成してもよく，特に本実施例に限定されるものではない。

【００２９】つぎに，前述した構成からなる本実施例の

作用について具体的な実験例を例示し説明する。

【００３０】実験例１

磁気ディスク１としては，図３および図４に示すように，ガラス基板５にフォトエッチングを施して円柱状の突部６を，円周方向に複数列形成した。その形成してある間隔は，磁気ヘッドとの相対移動方向の間隔をＬ１，相対移動方向に対し直角方向の間隔をＬ２，とするとＬ１≦Ｌ２であるＬ１：Ｌ２－１：５の関係になるように配置した．このガラス基板５の上にＣｒを素材とした下地層７，Ｃｏ合金を素材とした磁性層８，Ｃを素材とした保護層９を順に設け，さらに潤滑層を形成して所定高さの突起状パターンを形成した。

【００３１】実験例２

実験例１における突起状パターン４の形成間隔の関係を，Ｌ１≦Ｌ２であるＬ１：Ｌ２＝１：２に変更し，その他は実験例１と同様な構造の磁気ディスクを作成した。

【００３２】実験例３

実験例１における突起状パターン４の形成間隔の関係を，Ｌ１≦Ｌ２であるＬ１：Ｌ２＝１：１に変更し，その他は実験例１と同様な構造の磁気ディスクを作成した。

【００３３】比較例１

実験例１における突起状パターン４の形成間隔の関係を，図５に示すように，Ｌ１＞Ｌ２であるＬ１：Ｌ２＝２：１に変更し，その他は実験例１と同様な構造の磁気ディスクを作成した。

【００３４】上記磁気ディスクに対し，ミニモノシリックタイプのフェライトヘッドを用いてＣＳＳを繰り返した際の，磁気ディスク１と磁気ヘッドとの摩擦係数の推移について測定を行なった。

【００３５】図６に前記測定結果を示す．図６から明らかなように，磁気ディスク装置の起動可能条件である摩擦係数０．８以下をＣＳＳ３万回後に満たす突起状パターンの形成間隔は，Ｌ１≦Ｌ２の関係の場合であり，Ｌ１＞Ｌ２の場合には摩擦係数が１．０以上になってしまうことが判明した。

【００３６】このように本実施例の磁気ディスク１によれば，吸着を確実に防止し，ＣＳＳ耐久性を従来の磁気ディスクに比べて著しく向上させることができる。

【００３７】なお，本発明の磁気ディスク１に形成する突起状パターン４の配置間隔は，図７および図８に示すような場合も同様の効果がある。

【００３８】図７は磁気ディスク１のヘッドと接触し摺動する領域の一部を拡大した部分拡大平面図である。図７の様に突起状パターン４を千鳥状に配置した場合も，突起状パターンの形成間隔をＬ１≦Ｌ２とすることでＣＳＳ耐久性は優れたものとなる。

【００３９】図８は磁気ディスク１のヘッドと接触し摺動する領域の一部を拡大した部分拡大平面図である。図

８の様に突起状パターンの形状を磁気ヘッドとの相対移動方向に連続，または，一部間隔をあけた形状とした場合も，突起状パターン４が磁気ヘッドとの相対移動方向に連続して密に存在しているので，ＣＳＳ耐久性は優れたものとなる。

【００４０】なお，本発明の磁気ディスク１に形成する突起状パターン４は，実施例の様に基板５に形成する以外に，保護膜１０等に形成する方法でも良い。

【００４１】つぎに，本発明に関わる磁気ヘッドの実施例について図９および図１０により説明する。図９は本発明の磁気ヘッドを３レールモノリシック型磁気ヘッドに適用した一実施例の全体を示す斜視図であり，図１０は本発明の磁気ヘッドの摺動面の一部を拡大した部分拡大平面図である。

【００４２】図９に示すように，本発明の磁気ヘッド２７は，多結晶Ｍｎ－Ｚｎフェライト等で形成した略短矩形のスライダー２８を備えている。このスライダー２８の図示しない磁気ディスクに対向する面であるＡＢＳ（Ａｉｒ　Ｂｅａｒｉｎｇ　Ｓｕｒｆａｃｅ）面とされる図中斜線部で示す摺動面２９に，２本の溝３０，３０を磁気ディスクに対する相対移動方向と平行に凹設して，３本レール３１が形成されている。そして，図中中央の１本のレール３１と多結晶Ｍｎ－Ｚｎフェライトで形成した略コの字型のヘッドコア３２とが，適当なギャップ３３を介して図示しないガラス等により接合されている。ヘッドコア３２には，所望のコイル３５が巻かれている。また，コイル３５に電流を流して，あるいは誘導電流を検出してギャップ３３の部分で情報の記録・再生を行なうようにされている。

【００４３】また，前記磁気ヘッド２７の摺動面２９を構成する３本のレール３１には，所定形状，本実施例では前述した磁気ディスク１と同様の円柱状の突起状パターン４Ｃを磁気ディスクとの相対移動方向に複数列形成した．その突起状パターンが形成してある間隔は，磁気ディスクとの相対移動方向の間隔をＬ１，相対移動方向に対し直角方向の間隔をＬ２，とするとＬ１≦Ｌ２となるように配置した。

【００４４】本実施例の磁気ヘッド２７の表面に形成される突起状パターン４Ｃは，スライダー２８の摺動面２９にフォトレジストを塗布し，所定のパターンのフォトマスクを用いて露光し，現像，エッチング等を行ない，フォトレジストを基板から除去して，所定の高さの突起状パターン４Ｃが形成される。

【００４５】なお，本実施例においては，突起状パターン４Ｃの形状を円柱状としたが，角柱状，円錐台状，角錐台状等の適当な形状でよく，特に本実施例に限定されるものではない。

【００４６】また，本実施例においては，突起状パターン４Ｃを摺動面２９を構成する３本のレール３１のすべてに形成したが，摺動面２９を構成する３本レール３１

の両側のレールのみに形成してもよく、さらに，レール３１の全表面ではなく一部の表面にのみ形成してもよく，特に本実施例に限定されるものではない。そして，突起状パターン４Ｃはフォトエッチングだけでなく，放電加工，レーザ加工等の適当な加工方法により形成してもよく，特に本実施例に限定されるものではない。

【００４７】なお，本実施例においては，突起状パターン1Ｃをスライダーを形成している多結晶Ｍｎ－Ｚｎフェライトをフォトエッチングし作成したが，摺動面２９にカーボン（Ｃ）等の薄膜を形成した後に，フォトエッチング等で突起状パターン４Ｃをカーボン層等に形成してもよく，得に本実施例に限定されるものではない。

【００４８】上記のような構成からなる磁気ヘッド２７が吸着を確実に防止し，ＣＳＳ耐久性を従来の磁気ヘッドに比べて著しく向上させることができることが明白である。

【００４９】なぜならば，磁気ディスクと磁気ヘッドはＣＳＳ時に相対して接触，移動するので，前述した磁気ディスク１における，突起状パターンの配置とＣＳＳ耐久性との関係は，磁気ヘッド２７の突起状パターンの配置とＣＳＳ耐久性との関係に適用できるとともに，同様の効果を奏するからである。

【００５０】つぎに，本発明の磁気記録装置を磁気ディスク装置に適用した一実施例について図１１および図１２により説明する。図１１は本発明の磁気ディスク装置の一実施例の要部を示す平面図であり，図１２は側面図である。

【００５１】図１１および図１２に示すように，本実施例の磁気ディスク装置３６は，磁気ヘッド３７が支持装置３８の弾性を有するアームの先端に取りつけられて磁気記録媒体３９の上に吊持されている。そして，磁気記録媒体３９を回転させることにより，磁気ヘッドを磁気記録媒体３９の表面を走査させて，記録または再生を行なうようにされている．本実施例の磁気ディスク装置３６の磁気ヘッド３７には，前述した摺動面２９に突起状パターン４Ｃを形成した磁気ヘッド２７が用いられる。

【００５２】以上のように構成されている本実施例の磁気ディスク装置３６によれば，ＣＳＳ特性および吸着性を著しく向上させることができる。

【００５３】なお，磁気ディスク装置３６の磁気ヘッド３７に，従来の磁気ヘッドを用い，磁気記録媒体３９として．前述した磁気ディスク１を用いることによっても同様の効果を奏することができる。

【００５４】すなわち，磁気ディスク装置３６の磁気ヘッド３７あるいは磁気記録媒体３９のいずれか一方，あるいは両者に本実施例の磁気ディスク１あるいは磁気ヘッド２７を用いることにより，寿命が長く，安定した品質を長期間にわたり保持させることができる。

【００５５】なお，本発明は，前記実施例に限定されるものではなく，必要に応じて変更することができる。

【００５６】

【発明の効果】以上説明したように本発明の磁気記録媒体によれば，磁気記録媒体に形成する突起状パターンの最適な配置を確実に，かつ，明確に表示できるとともに，このように優れた技術的効果を有する磁気記録媒体を品質を安定させ，精度良く，正確に製造することができる等の極めて優れた効果を奏する。

【００５７】以上説明したように本発明の磁気ヘッドによれば，磁気ヘッドに形成する突起状パターンの最適な配置を確実に，かつ，明確に表示できるとともに，このように優れた技術的効果を有する磁気ヘッドを品質を安定させ，精度良く，正確に製造することができる等の極めて優れた効果を奏する。

【００５８】さらに，本発明の磁気記録装置によれば，寿命が長く，安定した品質を長期間にわたり保持させることができる等の極めて優れた効果を奏する。

【図面の簡単な説明】

【図１】本発明の磁気記録媒体の一実施例を示す平面図。

【図２】本発明の磁気記録媒体の表面部分拡大平面図。

【図３】本発明の磁気記録媒体の突起状パターンの要部を示す拡大縦断面図。

【図４】本発明の磁気記録媒体の表面部分拡大平面図。

【図５】従来の磁気記録媒体の表面部分拡大平面図。

【図６】本発明の磁気記録媒体の突起状パターンの間隔比と摩擦係数の関係を示す図。

【図７】本発明の磁気記録媒体の表面部分拡大平面図。

【図８】本発明の磁気記録媒体の表面部分拡大平面図。

【図９】本発明の磁気ヘッドを３レールモノリシック型磁気ヘッドに適用した一実施例の全体を示す斜視図。

【図１０】本発明の磁気ヘッドの摺動面の一部を拡大した部分拡大平面図。

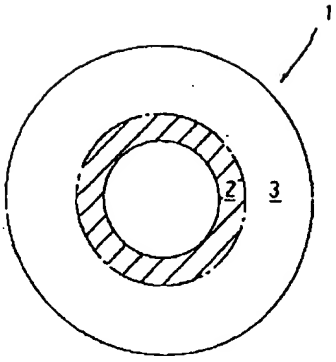
【図１１】本発明の磁気記録装置の一実施例の要部を示す平面図。

【図１２】図１１の側面図。

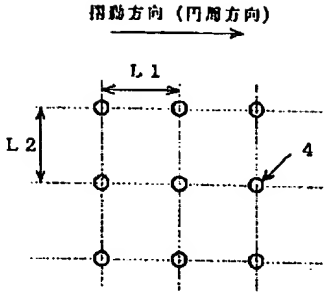
【符号の説明】

１　磁気ディスク
２　ＣＳＳ領域
３　データ領域
４，４Ｃ　突起状パターン
２７　磁気ヘッド
２９　摺動面
３１　レール
３６　磁気記録装置

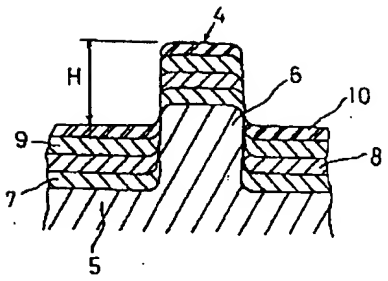
【図1】



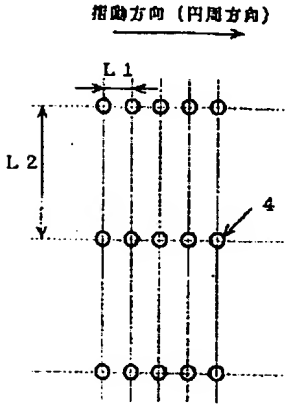
【図2】



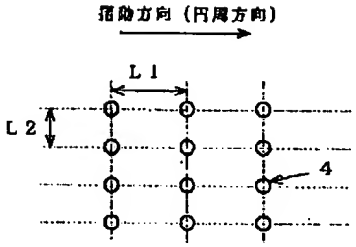
【図3】



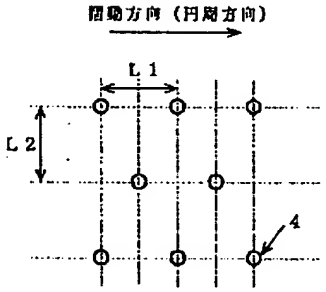
【図4】



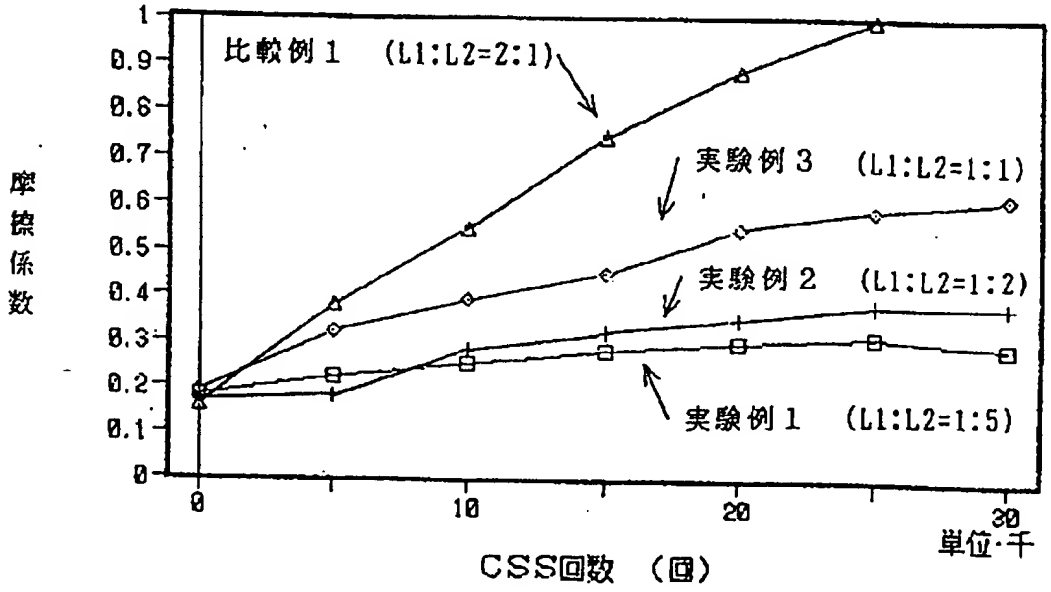
【図5】



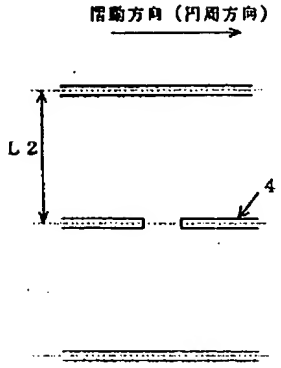
【図7】



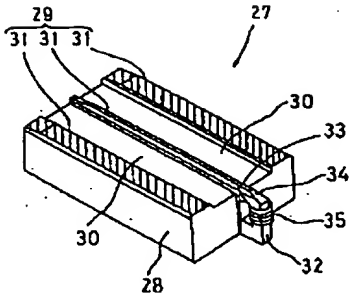
【図6】



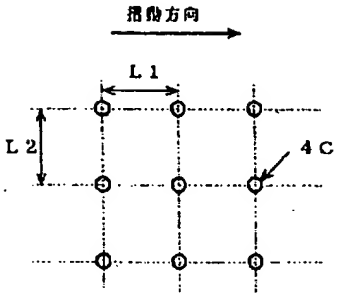
【図８】



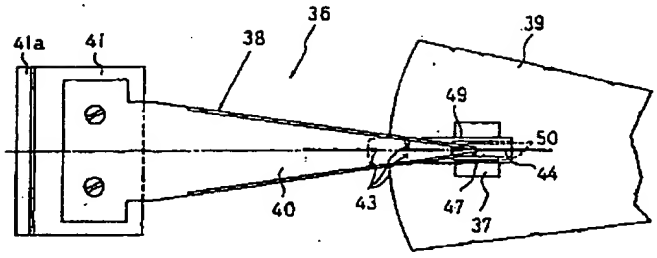
【図９】



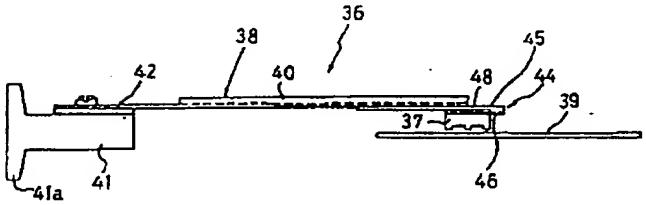
【図１０】



【図１１】



【図１２】



04467394

MAGNETIC RECORDING MEDIUM, MAGNETIC HEAD AND MAGNETIC RECORDER

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PUBLISHED: April 22, 1994 (19940422)
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ABSTRACT

PURPOSE: To provide a magnetic head having an optimum protrusionlike pattern in which attraction of the head to a magnetic recording medium is effective prevented and sliding durability is improved, a magnetic recording medium and a magnetic recorder.

CONSTITUTION: Many protrusionlike patterns are formed on a region in contact with and sliding with at least a magnetic head of a magnetic recording medium, many protrusionlike patterns 4C are formed partly at least on a sliding surface opposed to the medium of the head 27, and an interval formed of the patterns 4 and 4C has a relation of L1<=L2, where L1 is an interval of a relatively moving direction between the head and the medium and L2 is an interval of a perpendicular direction to the relatively moving direction.